A TRIDENT SCHOLAR PROJECT REPORT
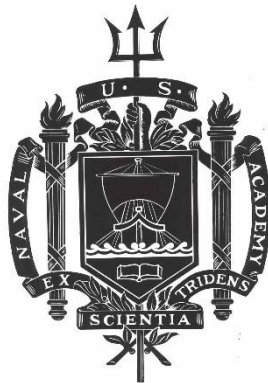
NO. 484

China's Export Effects: A Product-Level Analysis of Global Supply Chains, Comparative Advantage, and Crowding-Out

by

Midshipman 1/C Davis P. Katakura, USN

UNITED STATES NAVAL ACADEMY
ANNAPOLIS, MARYLAND

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)* 5-20-19	2. REPORT TYPE	3. DATES COVERED *(From - To)*

4. TITLE AND SUBTITLE

China's Export Effects: A Product-Level Analysis of Global Supply Chains, Comparative Advantage, and Crowding-Out

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Katakura, Davis, P.

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U.S. Naval Academy
Annapolis, MD 21402

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)
Trident Scholar Report no. 484 (2019)

12. DISTRIBUTION / AVAILABILITY STATEMENT

This document has been approved for public release; its distribution is UNLIMITED.

13. SUPPLEMENTARY NOTES

14. ABSTRACT
China's extraordinary economic growth has had a large impact on the world economy. Between 1995 and 2015, China's share in the world's total exports increased from 3.2% to 13.8%. The effect of China's sudden growth may have affected neighboring, developing economies that possessed a similar make-up to China in terms of labor resources and products produced. This paper attempts to address the effects of China's exports on the magnitude and composition of other countries' exports by analyzing a dataset of bilateral trade flows between countries, covering the period 1988-2016 at a highly disaggregated product level. Including the most recent data will include the exogenous shocks of the US Financial Crisis and the Great Trade Collapse of 2008-2009. Disaggregated products are classified by their sector of industry (e.g., electronics and clothing) and final usage in a global supply chain (e.g., intermediate inputs, final goods, and capital goods). Using a gravity model of trade, we quantitatively investigate both the crowding-out and crowding-in of trade due to China's exports. Standard trade theory of comparative advantage suggests if China is relatively good at exporting certain goods, trading partners will produce less (crowding-out), but those resources can be reallocated to new sectors and stages in global supply chains, increasing exports elsewhere (crowding-in). The results show that China's role exhibits a greater influence in crowding-in and crowding-out final goods relative to its effect on stimulating global supply chains. If China's exports remained constant at its 1988 levels, the rest of the world would have experienced around a 10% decrease in trade.

15. SUBJECT TERMS
China, trade, comparative advantage, crowding-in, crowding-out, supply chains

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE		33	19b. TELEPHONE NUMBER *(include area code)*

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39.18

CHINA'S EXPORT EFFECTS: A PRODUCT-LEVEL ANALYSIS OF GLOBAL SUPPLY CHAINS, COMPARATIVE ADVANTAGE, AND CROWDING-OUT

by

Midshipman 1/C Davis P. Katakura
United States Naval Academy
Annapolis, Maryland

_____
(signature)

Certification of Adviser(s) Approval
Assistant Professor Jacek A. Rothert
Economics Department

_____
(signature)
_____
(date)

Professor Katherine A. Smith
Economics Department

_____
(signature)
_____
(date)

Assistant Professor Douglas N. VanDerwerken
Mathematics Department

_____
(signature)
_____
(date)

Acceptance for the Trident Scholar Committee
Professor Maria J. Schroeder
Associate Director of Midshipman Research

_____
(signature)
_____
(date)

USNA-1531-2

Abstract

China's extraordinary economic growth has had a large impact on the world economy. Between 1995 and 2015, China's share in the world's total exports increased from 3.2% to 13.8%. The effect of China's sudden growth may have affected neighboring, developing economies that possessed a similar make-up to China in terms of labor resources and products produced. This paper attempts to address the effects of China's exports on the magnitude and composition of other countries' exports by analyzing a dataset of bilateral trade flows between countries, covering the period 1988–2016 at a highly disaggregated product level. Including the most recent data will include the exogenous shocks of the US Financial Crisis and the Great Trade Collapse of 2008–2009. Disaggregated products are classified by their sector of industry (e.g., electronics and clothing) and final usage in a global supply chain (e.g., intermediate inputs, final goods, and capital goods). Using a gravity model of trade, we quantitatively investigate both the crowding-out and crowding-in of trade due to China's exports. Standard trade theory of comparative advantage suggests if China is relatively good at exporting certain goods, trading partners will produce less (crowding-out), but those resources can be reallocated to new sectors and stages in global supply chains, increasing exports elsewhere (crowding-in). The results show that China's role exhibits a greater influence in crowding-in and crowding-out final goods relative to its effect on stimulating global supply chains. If China's exports remained constant at its 1988 levels, the rest of the world would have experienced around a 10% decrease in trade.

Keywords: China, trade, comparative advantage, crowding-in, crowding-out, supply chains

Acknowledgements

Contents

1   Introduction

Following its opening to trade during the 1970s and '80s, China quickly became the largest trading economy in the world. China's entry into the World Trade Organization (WTO) in 2001 only further expedited its export growth. China's share in the world's total exports increased to 13.8%, in 2015 surpassing a 50-year United States (US) record (Glenn and Sweeny, 2016). The increase in Chinese exports coincides with the global rise of exports (Figure 1). Within the last 45 years, trade has become more integrated and important to the global economy (Figure 2). Since total trade as a percentage of total Gross Domestic Product (GDP) has increased, China's export growth implies that China itself has become more important in the global economy. However, what exactly is China's impact on other countries?
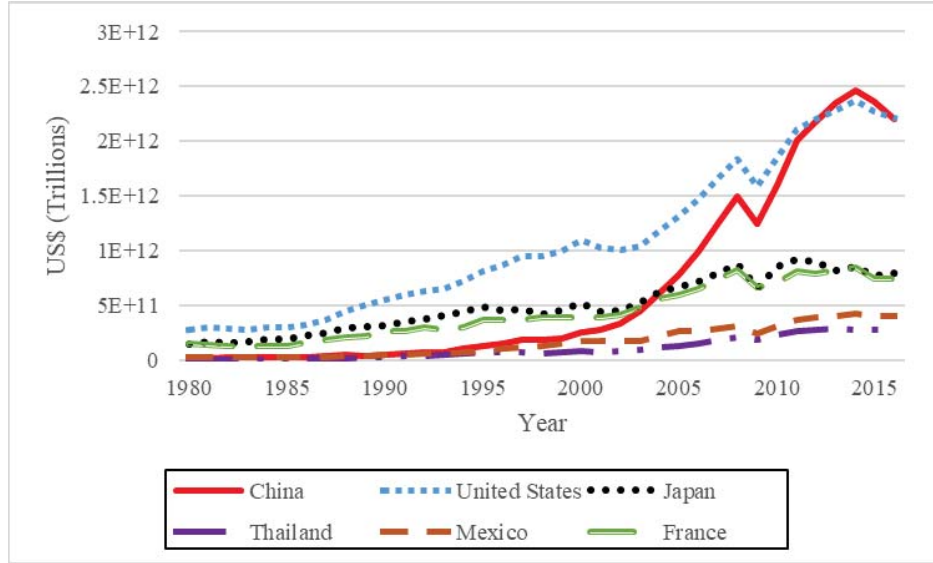
Figure 1: Exports of Goods and Services (Current $US)
Source: World Development Indicators

This paper analyzes the impact on other countries' trade using highly disaggregated UNCOMTRADE tradeflow data that not only classifies goods into sectors, but also into end-usage within global supply chains (raw materials, intermediate, final, and capital goods). That the dataset spans the years 1988-2016 is a significant update from previous literature, including the Great Trade Collapse of 2008–2009, an exogenous global demand shock that significantly altered both the quantity of money and the physical goods being exchanged (Figure 2) (Baldwin, 2009). We incorporate the effect of Chinese exports, varying across sector and end-use, in a standard gravity model to analyze bilateral trade flows among all other economies.

According to the highly disaggregated nature of the data with its inclusion of end-use classification, we are able to study three different (but overlapping) channels of the effect
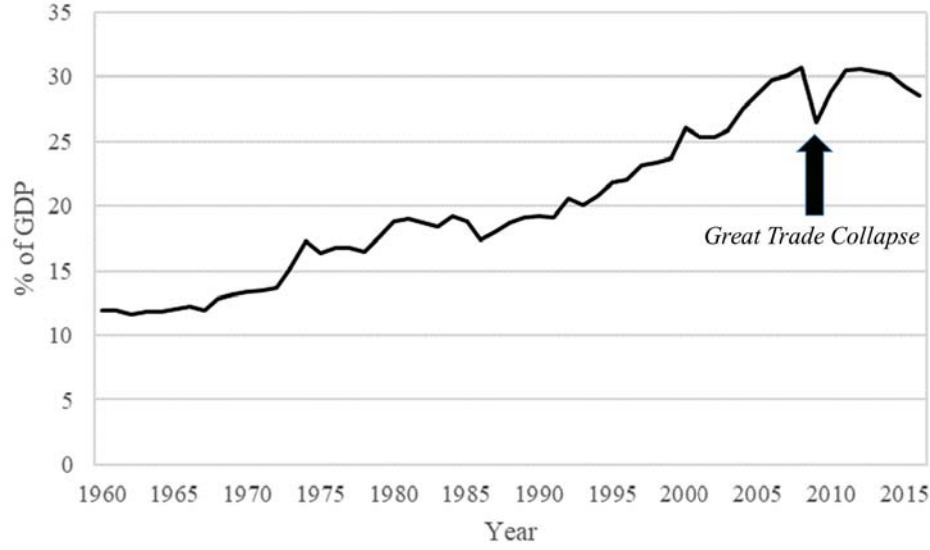
Figure 2: World Exports of Goods and Services (% GDP)
Source: World Development Indicators

that China has on global trade. (1) crowding-in of final goods: countries switch production towards industries in which they are relatively more productive. (2) crowding-in of final goods through supply chain inputs: specialization occurs along the entire production chain. (3) crowding-out: China has a relative productivity advantage in certain goods, forcing other countries to shift production towards other goods. As an example, if China's exports of finished, high technology goods stimulate Vietnam's exports of finished textiles, this would constitute a positive crowding-in influence of final goods (1). If China's exports of inputs to high technology (raw materials, intermediate, or capital goods) to Japan correspond with an increase in Japan's exports of finished, high technology goods, China would possess a crowding-in influence in a global supply chain (2). However, if China's exports of finished, high-technology manufactures to the US correspond to a decrease in US exports of high-technology manufactures, China would have a crowding-out effect (3). Our model investigates these three cases.

Our paper proceeds with an explanation of the dataset's composition, the derivation of our first-difference gravity model, and counterfactual analysis that assumes that China's exports remain at its 1988 levels. In summary, if China's exports remained constant at its 1988 levels, the rest of the world would have experienced a 10% decrease in trade. China's role exhibits a greater influence in crowding-in and crowding-out final goods relative to its effect on global supply chains.

2   Previous Studies

Recent empirical literature on trade with China can be categorized into three broad categories of China's export effects (crowding-in of final goods, crowding-in of supply chains, and crowding-out), the first two constituting positive trade growth and the third, negative. Much of the literature on developing countries focuses on China's neighbors in Asia, though some regionally focused papers include other areas, and others focus on the entire world (Qiu and Zhan, 2016). Such research aims to assess empirically China's competitive effects on other economies. Studies within this category employ empirical strategies such as the use of simple measures of trade output or regression models. These categories include: (2.1) crowding-in of final goods (2.2) crowding-in of supply chains, and (2.3) crowding-out.

2.1   Crowding-In of Final Goods

Several papers attempt to address what China's entry into the WTO and its subsequent rise to trade power have meant for global welfare. The IMF (2004) and Ghosh and Rao (2010) determine that the overall effect of China's entry into the WTO and the subsequent removal of certain trade quotas resulted in a small, yet positive increase in the global real GDP. Dimaranan et al. (2007) conclude that China has contributed to the increase in the variety and quality of exported products, resulting in an increase in aggregate welfare gains from 2005 to 2007. Bloom et al. (2014) analyze how China is projected to increase the long-run growth rate for OECD (developed) countries. Di Giovanni et al. (2014) determine using a Ricardian-Heckscher-Ohlin model that unbalanced productivity growth favoring China corresponds to larger global welfare than with a balanced China. This model states that a country's comparative advantage depends on its abundance of "endowments" (i.e. factors of production) relative to the rest of the world. The rest of the world benefits when China focuses on developing its disadvantaged sectors, so trading countries are better off when China's productivity growth differs by sector rather than all together. Overall, most of the literature has pointed to China as a positive effect both on welfare and growth for the rest of the world.

Not only the volume of trade, but also the modes of production have shifted because of China. In short, trade with China induces firms to shift their focus towards high-skilled and capital factors of production. In the US, Bernard et al. (2006) conclude that US domestic production shifts from low-skilled to capital-intensive industries. Additionally, high-skilled plants have greater survival rates than low-skilled plants because of exposure to Chinese exports. Mayer and Wood (2009) summarize previous literature on China's economic effects through the lens of the Heckscher-Ohlin (H-O) model. During its initial opening to trade during the 1970s and 80s, China shifted the status quo of comparative advantages between countries. China especially affected developing East Asian countries by reducing the labor primary production ratio, though not enough to hinder economic growth. Bloom et al. (2016) use China's accession to the WTO as an instrumental variable to explain how China induces European firms to innovate. According to their research, 15% of Europe's technological

upgrades from 2000 to 2007 can be attributed to trade competition from China.

2.2 Crowding-In of Supply Chains

Most studies utilize one of two empirical strategies to determine the presence of supply chain complementarity. A simple measures approach does not reveal causality, but it can evaluate the relative market share between countries and across different industries by comparing trade output across trade partners and sectors. Competition with China among Asian economies can be differentiated by sector. Particularly, China's trade has been substitutionary for low-technology products, while complementary for high-technology products (Fernald et al., 2003). China's growth in its exports has been correlated with its growth in imports, denoting the importance of a vertical supply chain in explaining the increase in trade within Asia (Gaulier et al., 2007). The second empirical strategy is regression. A regression approach attempts to identify causality while quantifying China's effects. A number of papers have attempted to ascertain the role of Chinese competition specifically in Asian economies. Eichengreen et al. (2007) use a gravity model to determine that Asian developing countries that focus on exporting consumption goods are more negatively affected than capital-intensive countries. In fact, China imported a significant portion of capital goods from its neighboring countries. According to Athukorala (2009), the effect of China's growth in labor-intensive exports is focused mainly on Korea, Singapore, Hong Kong, and Taiwan. Athukorala divides exports into parts, components, and final goods to determine that China's role in the global supply chain renders its regional crowding-out effect insignificant.

2.3 Crowding-Out

Another way China influences other countries' trade is through overtaking their market share of exports. Some research elects to focus on other regions of interest and segment the world into regions and levels of development. Using a regression approach, Greenaway et al. (2008) divide Asia into low, middle, and high-income economies and conclude that China significantly crowds-out high-income countries, while having an insignificant effect on low-income countries. Lall et al. (2005) focus on China's effect in Latin American and Caribbean countries (LAC), concluding that products produced in LAC on the whole complement exports from China rather than compete. However, Jenkins (2008) and Freund and Ozden (2009) conclude that LAC countries lose their market share in US imports to China. Hanson and Robertson (2009) found that increased LAC supply coupled with decreased US demand for imports has slowed LAC growth in exports of manufacturing. Jenkins and Edwards (2015) found that South African exports to Sub-Saharan Africa, the EU, and US all significantly shrank because of Chinese competition. Giovannetti and Sanfilippo (2009) likewise attribute a decrease in African exports to the EU and US to an increased market share of Chinese exports. Regardless of region, developing countries as a whole may be facing "deindustrialization" because of Chinese competition by stunting growth up the global value chain (Jenkins and Barbosa, 2012). Hanson and Robertson (2008) analyze the effect of China's expanding export production on the change in demand for developing countries'

exports by focusing on countries where manufacturing accounts for a large majority of their exports. They find that if China kept supply of their exports constant, manufacturing-based countries would have observed a 0.8% to 1.6% increase in demand for their own exports. Similarly, we find that had Chinese exports remained at earlier levels, trade between other countries would have been slightly higher (see section 6).

2.4   Other Effects

For developed countries, including the US and most of Europe, the majority of the voiced concern on China's crowding-out effect has been over export deflation and reallocation of resources and labor. For the US in particular, China has affected the labor force differently by region and sector. As shown in a widely read paper by Autor et al. (2013), regions of the US exposed to Chinese manufacturing have experienced a decrease in employment and labor force participation. At the industry level, Chinese and US employment growth are negatively correlated (Ebenstein et al., 2011). However, workers are affected differently based on their sector of employment, as higher wage workers fare better in regards to wage losses than their lower-wage counterparts (Autor et al., 2014).

Supply chain effects have been assessed through its influence on the labor force of different industries. Scissors et al. (2012) argue that instead of simply withstanding the effects of China, some workers actually benefit from the influx of cheap Chinese imports. Such imports in fact support job creation in certain sectors of the supply chain. Similar shifts in labor can be seen in Europe. Employment in European countries, including Denmark and Norway, shifted towards more technologically advanced firms because of trade with China (Bloom et al., 2016; Utar, 2014; Balsvik et al., 2015).

2.5   Our Contributions

Answering the question of China's trade influence is difficult because China's influence can be differentiated across regions, sectors of exports, or steps within a supply chain. Previous studies on China's as an exporter look specifically within its (1) crowding-in of final goods, (2) crowding-in of supply chains, and (3) crowding-out, but not relative to one another. Furthermore, previous researchers focus on China's exports only within certain regions, within particular sectors or only within stages of supply chains. Our research compiles a dataset and takes into account both the *sector* and *usages* of exports to empirically analyze China's effect within each of those three spheres of influence from 1988-2016. Through a growth accounting procedure, we generate a counterfactual where we shut down the effects of each of these channels, observing the importance of each.

3   Motivation and Theory

What does trade theory predict about the impact of China's entry into global markets on trade flows among other countries? We will interpret that impact through the lens of

trade models that rely on comparative advantage.

The idea of comparative advantage dates back to the early 19th century. According to a Ricardian trade model, countries will export products that they are relatively good at producing (i.e., they have a comparative advantage in). The Heckscher-Ohlin model explains how differences in resource endowments could be a source of such comparative advantage between countries. For example, China has a relative abundance of low-cost labor compared to the US that has a relative abundance of capital. Because of that difference, it is relatively easier to produce certain manufacturing goods such as children's toys or t-shirts in China, making these goods cheaper. As a result, China will be able to export them at a low price on the global market. Conversely, due to a very high capital-intensity of aircraft production, it is the United States that exports aircraft, not China.

Due to the large size of its economy, China's entry into the global markets altered the pattern of comparative advantage among other countries. For example, countries that used to have a relatively large amount of cheap labor may no longer appear that way, if their average wages are substantially above the ones in China. This can have two kinds of effects. China may replace them, as the main source of labor-intensive exports, or it can induce them to produce and export different types of goods than they did before. The next two sections will explain it in more detail.

3.1 Crowding-In

3.1.1 Final Goods

China's entry and subsequent dominance in global trade presented a stimulus for other exporting countries that shifted the spectrum of comparative advantage. Our research examines whether China's presence in global trade crowds other countries into sectors that China does not specialize in. This crowding-in effect would be reflected by these countries choosing to export goods they became relatively good at producing, leading to an increase in global trade.

Consider the following example of crowding-in. China exports children's toys (final good) to the US, capitalizing on its abundance of low-skilled labor. The US exports computers (final good) to China and the rest of the world, making use of its abundance of high-skilled labor. By comparative advantage, both the US and China can focus on exporting what they are relatively good at producing. The US and China both acquire more children's toys and computers than if they decided to produce a combination of both entirely on their own. Specialization through trade allows countries to produce more, and thus increase global trade through their exports.

3.1.2 Supply Chains

By just focusing on final goods, we might risk not including the gains of trade at international stages of production. China's entrance into global markets allows other countries to focus on other stages of production through the mechanism of comparative advantage.

Because of this greater specialization, China may increase the trade of goods that are further down the supply chain. Global supply chains are networks of raw materials, intermediate, final, and capital goods that allow multinational firms to both sell their products abroad more efficiently and achieve lower costs of production. With China's abundance of low-cost labor, China may possess a comparative advantage at producing inputs (raw materials, intermediate, and capital goods) to final goods, exporting these inputs to countries who process these inputs domestically and export final goods as a result. For example, consider if China's labor force is especially apt to producing inexpensive cell phone parts. The US may choose to import these inputs, domestically manufacture, and export cell phones (final good) to the rest of the world.

An important property of global supply chains is that industries in reality exhibit economies of scale in which output will increase by a factor greater than the proportionate increase of resources. Economies of scale applied to industries of productions are classified as external economies, which result in specialized suppliers localized in a particular geographic location. External economies allow economies of scale to exist within each step of the supply chain. Firms that focus on producing intermediate or capital goods free up producers and developers to specialize efficiently in final goods. As each country focuses on a specific stage of an industry's supply chain, increasing output driven by export demand decreases the overall costs of production. An expanded global supply chain would suggest that all countries involved would experience an increase in the value and volume of their exports, and thus economic growth.

3.2   Crowding-Out

Countries that produce identical goods with respect to industry compete internationally. If effective, competition should allow more-productive firms to outlive less-productive firms. In other words, countries that can produce with lower costs are able to lower their prices and gain a greater share in the market through capturing the demand of potential importers. Countries that are not able to efficiently cut their production costs are forced out of the market and into other industries.

Under comparative advantage, countries that are crowded out from certain sectors of trade reallocate their resources to producing within a different sector of trade in which they have a relative abundance of inputs. This reallocation of global trade is in reality difficult for a country to realize quickly. Our question of crowding-out focuses on whether China's role as an exporter disrupts the status quo of an existing trade relationship, decreasing the exports of the now crowded-out exporter. For example, suppose Japan is an exporter of inexpensive, labor-intensive manufactures. Our research seeks to determine the degree to which Japan's exports of these is reduced by China's trading presence.

4 Data

4.1 Data Sources

The data for the project comes from the United Nations International Trade Statistics Database (UNCOMTRADE).[1] The dataset begins in 1988, marking the adoption of the Harmonized System (HS) classification system, and includes years up to 2016. The dataset records bilateral trade flows, measured in value of current US dollars, between all country pairs at various levels of aggregation. The levels of aggregation range from the two-digit level (99 different industries), four-digit level, and six-digit level (over 5,000 combined different industries).

4.2 Harmonized System Classification

HS classification has undergone several revisions since its adoption in 1988, denoted as H0. Subsequent revisions occurred in 1996 (H1), 2002 (H2), 2007 (H3), and 2012 (H4). In order to translate between these HS classification revisions, the UN Statistics Division (UNSD) provides correspondence tables.[2] The length of HS code specification determines the code's level of disaggregation (i.e., specificity). Additional digits appended at the end of a two-digit HS code provide an increasingly disaggregated description.[3] This comprehensive list forms a hierarchy of broad categories of goods totaling the values of multiple disaggregated goods that share the same prefix (e.g. nested beneath every two-digit code are multiple four-digit codes). On the broadest level of classification, HS codes are divided into 21 different sections of 2-digit codes. At maximum disaggregation, six-digit codes label the most specific classification of a product. For example, in Figure 3, the two-digit code for "musical instruments, parts and accessories" is 92. Further disaggregation into "wind instruments (brass, wood, bagpipes)" awards a four-digit annotation, in this case 9205. Within 9205 are the six-digit codes, 920590—"wind instruments except brass"—and 920510—"brass-wind instruments."

4.3 Stages of Processing Classification

In order to analyze global supply chains, an additional descriptor denoting the usage within the supply chain was appended to each HS code. The UN Conference on Trade and Development (UNCTAD) provides Stages of Processing (SoP) codes. SoP codes fall into four categories: raw materials, intermediate goods, consumer goods, and capital goods. World Integrated Trade Solutions (WITS) provides correspondence tables that match six-digit HS codes of a given HS revision with a corresponding SoP code.[4] As illustrated in Figure 4, each HS section can be divided into four main stages of the supply chain process with a fifth,

---

[1] UN Comtrade Database, https://comtrade.un.org/data/

[2] Trade Statistics Branch of the UN Statistics Division, "Correspondence Tables," https://unstats.un.org/unsd/trade/classifications/correspondence-tables.asp

[3] 2012 Harmonized Tariff Schedule of the United States (USITC Publication 4368)

[4] WITS Reference Data, https://wits.worldbank.org/referencedata.html

Harmonized System (HS) Classification Example

Year	Trade Flow	Reporter	Partner	HS Commodity Code	Commodity	Qty Unit	Qty	Trade Value (US$)
1988	Import	Australia	USA	92	Musical instruments, parts and accessories	No Quantity	N/A	8463448
1988	Import	Australia	USA	9205	Wind musical instruments (brass, wood,bagpipes)	Number of items	12494	2018819
1988	Import	Australia	USA	920590	Wind musical instruments except brass	Number of items	10543	1473549
1988	Import	Australia	USA	920510	Brass-wind instruments	Number of items	1951	545270

Figure 3: Musical Instruments Commodity Codes
Source: UNCOMTRADE

"other," category for HS codes without a corresponding SoP code. Some six-digit HS codes beginning with "16" are "raw materials," some are "intermediate goods," etc.
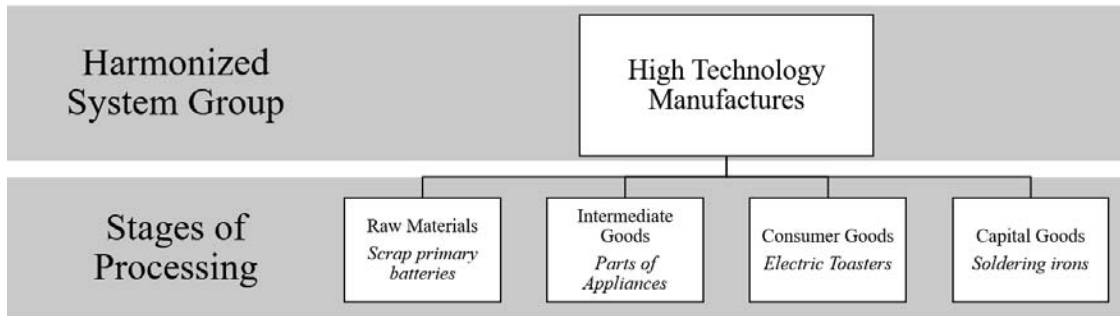
Figure 4: HS Group and SoP Classification Hierarchy Example

4.4   Distance and GDP

Measures that capture country-specific trade propensities and trade-costs are typically used in estimated gravity models. The World Bank's World Development Indicators (WDI) provide information on nominal, real, nominal per capita, and real per capita GDP's of each country.[5] Distance metrics were provided by the CEPII database. Distance metrics include not only geographical distances (in kilometers), but also additional indicators of whether the two countries share a border, common language, or past colonial relationship (Mayer and Zignago, 2011). Recent literature utilizes all of these distance factors to adequately account

---
[5]DataBank, http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators&

for distance between two countries (Shepherd, 2016). In order to group 247 countries into larger categories, countries were divided in accordance to UN geographic regions. Utilizing regions allows both a reduction in the number of observations by collapsing countries based on regions and the capability to determine broad regional effects. Additionally, each country is identified as either a developed or developing country according to the UN Statistics Division.[6]

4.5   Data Summary

Within our panel dataset spanning 1988 - 2016, the recorded combinations of 247 importers interacted with 246 exporters comprise 45,517 unique trading pairs (see Appendix A.1 for full list of countries).[7] Each traded product designated with an HS code by UNCOM-TRADE is assigned two descriptions within the dataset: its designation in a supply chain (i.e., raw material, intermediate good, etc.) and its aggregate industry. Designation in the supply chain results from HS–SoP correspondence tables that pair a six-digit HS product code with a unique SoP value. Aggregate industries (i.e., product groups) result from a three-step aggregation. First, the trade values of all six-digit HS products are indexed by their two-digit prefix. Second, two-digit HS product chapters are indexed into 21 HS sections.[8] Third, the 21 sections are indexed into 7 product groups as illustrated in Figure 5 (see Appendix A.4 for complete composition of HS sections) in similar fashion to compilations of SITC codes by Athukorala (2009) and Eichengreen et al. (2007).[9] These product groups then further decompose into SoP categories (5 total: raw, intermediate, consumer, capital, and other goods). A unique observation of a trade value in nominal US dollars is therefore a grouping of year, importer-exporter pair, product group, and SoP category. For example, a hypothetical trade of $3,000 from the US to Japan in 2010 of electronic intermediate goods would constitute a single observation.

Group	Description	Included HS Sections
1	Consumables	1, 2, 3, 4
2	Minerals	5, 6
3	Plastics	7
4	Textiles/Clothing/Fashion	8, 11, 12, 14
5	Wood Products	9, 10
6	Metals/Articles of Stone	13, 15
7	High Technology Goods	16, 17, 18

Figure 5: Product Group Descriptions

---

[6]UN Statistics Division, https://unstats.un.org/unsd/methodology/m49/

[7]Trading pairs are ordered pairs with missing values since not all countries trade with each other.

[8]The last two sections, 22 and 22, are omitted in accordance to as "Special Classification Provisions"

[9]19-Arms And Ammunition, 20-Miscellaneous Manufactured Articles, 21-Works Of Art, Collectors' Pieces And Antiques are omitted due to issues of reporting.

5 Empirical Model

The most widely used tool to analyze bilateral trade flows is the gravity model of trade, reminiscent of Newton's Law of Gravity (1):

$$F_{ijt} = G\frac{M_{it}^{\alpha}M_{jt}^{\beta}}{D_{ij}^{\theta}}. \tag{1}$$

The response variable, F_{ijt} represents the trade flows from exporting country j to importer i in year t. M measures nominal GDP of a country in a given year, and D measures distance between countries i and j. Countries that possess a larger economic mass would have a larger export variety, more options to trade, and would demand higher amounts of imports. Therefore, large values for M_i or M_j, would correspond to high volumes of trade flows between the country pair. On the other hand, increasing distance would decrease the predicted value of trade flows because factors such as geographic distance and tariffs make trading more expensive (Head, 2003).

The coefficients α, β, and θ from (1) represent the importance of GDP and trade distance to importers and exporters. They would be estimated by ordinary least squares after taking the logarithm of both sides to linearize the model:

$$lnF_{ijt} = \alpha_0 + \alpha lnM_{it} + \beta lnM_{jt} - \theta lnD_{ij} + \epsilon_{ijt}. \tag{2}$$

Note that an error term has been added to account for unexplained variation in log trade flows. Ordinary least squares assumes ϵ_{ijt} are distributed normally around zero.

In general, "distance" can refer to any barrier to trade, such as tariffs, an indication of a shared language, or the presence of a shared border. Gravity model literature comprises distance as below,

$$lnD_{ij} = b_0 + b_1 ln(distance)_{ij} + b_2 contig_{ij} + b_3 commlang_{ij} + b_4 colony_{ij} + b_5 commcol_{ij} \tag{3}$$

wherein $ln(distance)_{ij}$ represents the log distance in kilometers between countries i and j, *contig* is a dummy variable indicating whether the countries share a border, *commlang* indicating if both countries share a language, *colony* indicating if the countries were in a colonial relationship, and *commcol* indicating if both countries shared the same colonizer (Shepherd, 2016).

5.1 China Effect

An augmented gravity model allows for the incorporation of additional factors that may affect trade. Since our augmented gravity model analyzes global supply chains, we must be able to categorize commodities with its end-use via SoP classification. Each commodity,

k therefore requires an additional descriptor to analyze the supply chain dimension. Since we believe that China's supply chain influence differs by industries, we determine China's export effects through an augmented gravity model with coefficient estimates varying by commodity, k (HS group) and supply chain end-use, s (SoP code). The augmented gravity model takes the following form in log-level values:

$$F_{ijkst} = \alpha_0 + \beta_1 ln M_{it} + \beta_2 ln M_{jt} - \beta_3 ln D_{ij} + \text{``China Effect''} + \epsilon_{ijkst}. \tag{4}$$

Of primary interest are the explanatory variables measuring the *"China Effect"* for all possibilities of countries and their commodities to which China has exported.

To fully capture China's exports effect on trade between country i and j, our proposed model accounts for the two possible directions of China's exports, i.e. whether China exports to the exporter, j or the importer, i in the trade relationship between i and j. Using a previous example, if the US (the exporter) exports to Japan (the importer), China's export effect is accounted for in its exports both to the US and Japan.

For the left-hand side response variable, we let $F_{ijkst} = ln(TradeFlows_{ijkst})$, where trade flows between importer i, exporter j, of commodity and end-use ks, at time t is measured in current US dollars. The full empirical model, including standard gravity model variables for country-specific trade propensities, is as follows:

$$\begin{aligned} F_{ijkst} = \tau_i + \omega_j + \alpha_t + \xi_s + \beta_0 F_{ijks,t-1} + \beta_1 ln(GDP_{it}) + \beta_2 ln(GDP_{jt}) - \beta_3 ln D_{ij} \\ + \sum_{k's'} \delta_{ks,k's'} F_{i,China,k',s',t-1} + \sum_{k's'} \phi_{ks,k's'} F_{j,China,k',s',t-1} + \epsilon_{ijkst} \end{aligned} \tag{5}$$

where $\tau_i, \omega_j, \alpha_t$, and ξ_s are the fixed effects for the importer, exporter, year, and five SoP groups, respectively. Adding fixed-effects variables for both the importer and exporter captures the price index of exports of all countries, controlling for "multilateral resistance" (Redding and Venables, 2003; Arvis and Shepherd, 2012). Multilateral resistance, termed by Anderson and van Wincoop (2003), refers to the average trade barriers a country, say exporter, j, faces from all other countries excluding the importer, i. To use a three country example, consider Mexico and Australia both exporting to Argentina. Assuming that both Mexico and Australia are similar economic masses and are comparable distances from Argentina, a standard gravity model would predict similar exports to Argentina from both countries. The simple gravity model does not take into account that Mexico borders the US, an adjacent economic giant that attracts Mexico's exports and effectively diverts Mexico's exports to Argentina. Adding fixed effects for all countries included in the dataset suffices to control for multilateral resistance (Redding and Venables, 2003).

$\delta_{ks,k's'}$ and $\phi_{ks,k's'}$ measure the effect of China's exports of commodity and end-use $k's'$ to the importer (i) and exporter (j), respectively on j's exports to i. Both of these matrices of coefficients within equation (5) sum over China's exports of industry group k' and SoP end-use s'. The coefficient estimates, say from $\delta_{ks,k's'}$, are resultant from all China's possible

export combinations of k' and s' on all combinations of all exports of k and s from country j to country i. Since there are seven industry groups and five SoP categories, there are a total of 35 ks and $k's'$ pairings that describe a uniquely traded commodity-end use product. In other words, analysis of China's export effects is in two layered dimensions: the industries that China exports and the end-use of the products within those industries. The estimated parameters (in this example, for $\delta_{ks,k's'}$) are organized into a square, $(k \times s) \times (k' \times s')$, or a 35×35 matrix as follows:

$$
\begin{bmatrix}
\delta_{11,11} & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \delta_{11,75} \\
\vdots & \delta_{12,12} & & & & & & & & & \vdots \\
\vdots & & \delta_{13,13} & & & & & & & & \vdots \\
\vdots & & & \delta_{14,14} & & & & & & & \vdots \\
\vdots & & & & \delta_{15,15} & & & & & & \vdots \\
\vdots & & & & & \ddots & & & & & \vdots \\
\vdots & & & & & & \delta_{71,71} & & & & \vdots \\
\vdots & & & & & & & \delta_{72,72} & & & \vdots \\
\vdots & & & & & & & & \delta_{73,73} & & \vdots \\
\vdots & & & & & & & & & \delta_{74,74} & \\
\delta_{75,11} & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \delta_{75,75}
\end{bmatrix}.
\tag{6}
$$

The coefficient that specifies the effect of Chinese exports of plastic intermediate goods (group 3, SoP 2) on high-technology final goods (group 7, SoP 3), for example, would be $\delta_{73,32}$. A similar matrix stores the $\phi_{ks,k's'}$ values representing China's effects on exporters, j.

If $\delta_{ks,k's'} < 0$, then there would be evidence that China is in fact crowding out trade with other countries; for this particular product k, China produces a substitute product. On the other hand, if $\delta_{ks,k's'} > 0$, then there would be evidence that China's presence crowds-in other countries by increasing their exports, or in other words that China and the other country's products are complements to one another.

5.1.1   Crowding-In: Final Goods

Under comparative advantage, countries may respond to a surge of China's exports of final goods by shifting their resources to other sectors. Chinese exports act as a stimulus for an exporting country to shift its production away from sectors where China has a comparative advantage. Consider again an example of trade flows from the US (exporter) to Japan (importer). If China crowds in final goods through its exports, China's trade with the US would correspond to an increase of different final goods exported from the US to Japan (Figure 6a).

Within the empirical model (5), China's export effects via its exports to the exporter
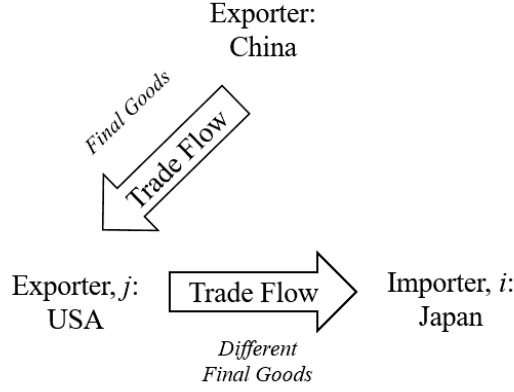
Figure 6a: Crowding-in: Final Goods

through supply chains, as illustrated in Figure 6b, are captured by the following summation of the $\phi_{ks,k's'}$ parameters:

$$\sum_{k's'} \phi_{ks,k's'} F_{j,China,k',s',t-1} \tag{7}$$

when $s = s' = 3$ for China's effect of final goods on other final goods.

5.1.2   Crowding-In: Supply Chains

Because of comparative advantage, countries may respond to Chinese exports by exporting complementary goods along a global supply chain. Exporting countries change the composition of their trade by producing final goods in response to Chinese exports of final good inputs. Again using the US-Japan example, China's exports of inputs to final goods (i.e., raw materials, intermediate, and capital goods) to the US would correspond to an increase of US exports final goods to Japan (Figure 6b).
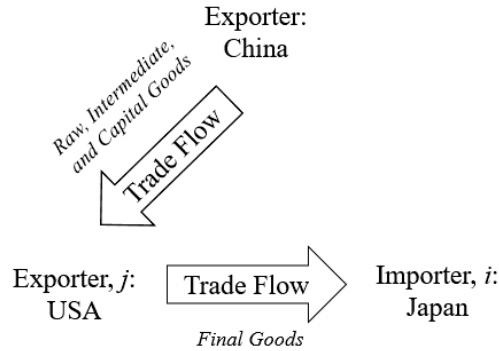

Figure 6b: Crowding-in: Supply Chains

Within the empirical model, China's export effects via its exports to the exporter through supply chains, as illustrated in Figure 6b, are captured by the following summation of explanatory $\phi_{ks,k's'}$ parameters:

$$\sum_{k's'} \phi_{ks,k's'} F_{j,China,k',s',t-1} \tag{8}$$

when $s = 3$ and $s' = 1, 2$, or 4 for China's export effects of raw materials, intermediate, and capital goods on the exporter's exports of final goods.

5.1.3 Crowding-Out

When China specializes in a specific commodity, other exporting countries specializing in the identical commodity may suffer decreased demand for these exports. If China were to export the same final goods to Japan that the US also exported to Japan, US exports may decrease as the US loses its share in the market (Figure 6c).
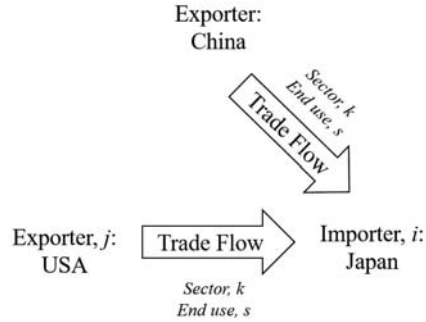

Figure 6c: Crowding-Out

Within the matrix of $\delta_{ks,k's'}$ parameters, the crowding-out effects presented by China's exports to the importing country are captured by:

$$\sum_{k's'} \delta_{ks,k's'} F_{i,China,k',s',t-1}. \tag{9}$$

when $k = k'$ and $s = s'$. These parameters would be represented as the diagonal of matrix (6).

6   Results

We estimate equation (5) using Ordinary Least Squares (OLS) in order to obtain fitted values, $\hat{F}_{ijkst}$, for each trade observation (Table 1). Predicted values for a gravity model estimated by OLS are log-levels. To observe China's effect within its crowding-in and

crowding-out channels of influence, counterfactual predicted values are estimated assuming China's exports stayed at 1988 levels.

The results from Table 1 display the parameter estimates for the standard gravity model variables. The masses (GDP's) of i and j are positive and highly significant, while the "log(distance)" term is negative and strongly significant. These parameter directions are as expected for a standard gravity model. The statistically significant "lag of trade flows" coefficient reveals the persistence in trade flows. Indications of shared border, language, and colonizer are all positive and significant. Not displayed in Table 1 but included in the regression are the importer and exporter fixed effects to account for multilateral resistance (Redding and Venables, 2003), end-use fixed effects, and year fixed effects (a total of 526 coefficients). Additionally, the $35 \times 35 \times 2$ China exporter coefficients (the effects of China's exports of commodity and end-use $k's'$ to importer i and exporter j on country j's exports to i of commodity and end-use ks) are not represented on the table.

Table 1: Parameter Estimates

Variable	Coefficient	(s.e.)	p-value
GDP_i	0.196	(0.003)	0.000
GDP_j	0.043	(0.004)	0.000
lag of trade flows	0.748	(0.000)	0.000
Distance			
log(distance)	-0.344	(0.001)	0.000
share border	0.163	(0.004)	0.000
shared official language	0.077	(0.004)	0.000
shared minority language	0.053	(0.004)	0.000
colony	0.092	(0.006)	0.000
common colonizer post 1945	0.199	(0.004)	0.000
current colony	0.135	(0.021)	0.000
colony post 1945	0.184	(0.008)	0.000
same country	0.084	(0.006)	0.000
End-use			
inputs	-0.035	(0.022)	0.120
final goods	-0.071	(0.021)	0.001
capital goods	-0.153	(0.029)	0.000
other	-0.737	(0.032)	0.000

Adjusted $R^2 = 0.8011$
$N = 4,820,581$

6.1   Counterfactuals

To investigate China's crowding-in effect of reallocating final goods, we set $F_{j,China,k',3,t-1}$ (in equations (5) and (7)) to $F_{j,China,k',3,1988}$ for every exporter j, commodity group k', and year $t > 1988$ (China's exports to j of final goods). Using this counterfactual data, we applied the model to find the counterfactual predicted values, $\hat{F}_{CI}$ of trade if China's exports of final goods to an exporter remained at its 1988 levels.

To examine China's crowding-in effect on global supply chains, we set $F_{j,China,k',1,t-1}$, $F_{j,China,k',2,t-1}$, and $F_{j,China,k',4,t-1}$ (in equations (5) and (8)) to $F_{j,China,k',1,1988}$, $F_{j,China,k',2,1988}$, and $F_{j,China,k',4,1988}$ for every exporter j, commodity group k', and year $t > 1988$ (China's exports to j of raw materials, intermediate, or capital goods). Applying the model generates $\hat{F}_{SC}$, predicted values assuming China's exports of inputs had remained at their 1988 levels.

Analyzing China's crowding-out effect takes into consideration China's exports of final goods to the importing country, we set $F_{i,China,k',3,t-1}$ (in equations (5) and (9)) to $F_{i,China,k',3,1988}$ for every exporter j, commodity group k', and year $t > 1988$. Applying the model with these counterfactual model produces predicted values of $\hat{F}_{CO}$.

Investigating China's total export effect would consider China's exports to the importing and exporting country. This would require setting both $F_{i,China,k',s',t-1}$ and $F_{j,China,k',s',t-1}$ (in equation (5)) to $F_{i,China,k',s',1988}$ and $F_{j,China,k',s',1988}$ respectively for every importer i, exporter j, commodity group k', end-use s', and year $t > 1988$. The counterfactual model outputs predicted values of $\hat{F}_{TOTAL}$

We note that the fitted point estimates using the original and counterfactual values face systematic bias that others have observed in previous literature. The so-called "adding up" problem is the issue of over-predicting trade flows when summing across country pairs or years (Arvis and Shepherd, 2012). Since OLS regression accounts for a log-linearized dependent variable, translating predicted values of log-level of trade back to trade values requires taking the exponential of the predicted, log-level trade flow. For every fitted log value that is overestimated, exponentiating dramatically overvalues the predicted trade flow, sometimes by orders of magnitude. Predicted values that are underestimated, however, have a negligible impact relative to their overestimated counterparts, as the exponentiation of small or negative numbers is close to 0. In other words, the counterfactual $\hat{F}_{CI}$, $\hat{F}_{SC}$, and $\hat{F}_{CO}$ exhibit the same systematic bias of the "adding up" problem. Therefore, though the fitted values are inaccurate, we can analyze the percent deviation.

In order to address this bias, we re-normalize the fitted values through utilizing trade-weighted averages (TWA_{ijkst}). This trade-weighted average is calculated as the \$US value of each trade flow, $e^{F_{ijkst}}$ divided by the total trade (\$US) of its given year, t:

$$TWA_{ijkst} = \frac{e^{F_{ijkst}}}{F_t}. \tag{10}$$

The difference between the fitted values of the full model and the counterfactual fitted values (C) constitute the counterfactual effect and are calculated as follows:

$$d\hat{F}^C_{ijkst} = \hat{F}^C_{ijkst} - \hat{F}_{ijkst}. \tag{11}$$

TWA_{ijkst} is then multiplied by $d\hat{F}^C_{ijkst}$ and collapsed by year to calculate the trade-weighted counterfactual effect:

$$d\hat{F}^C_t = \sum_{ijks} TWA_{ijkst} \cdot d\hat{F}^C_{ijkst}, \forall t. \tag{12}$$

Finally, re-normalizing $d\hat{F}^C_t$ to the observed trade value and calculating the annual trade counterfactual is as follows:

$$\hat{F}^C_t = F_t \cdot (1 + d\hat{F}^C_t), \forall t. \tag{13}$$

$\hat{F}^C_t$ is the re-normalized predicted value of trade for each year, t if China's crowding-in effect was held constant at its 1988 level. Graphically, $\hat{F}^{CI}_t$, $\hat{F}^{SC}_t$, $\hat{F}^{CO}_t$, and $\hat{F}^{TOTAL}_t$ can be plotted alongside the true values of F_t in the data (Figure 7). Each line in the graph relative to the true data illustrates global trade flows without China's influence in each of the above three channels with an additional case depicting China's total export influence. Figure (8) reorganizes the counterfactual information into percent deviation from the true data.
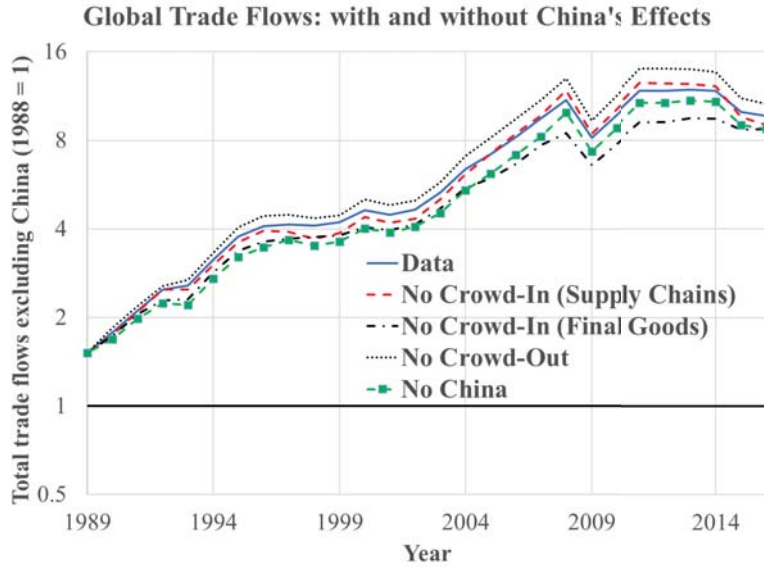

Figure 7: Counterfactual Trade Path

6.2 Interpretation of Results

Based on our results, if Chinese total exports had stayed at their 1988 level, trade flows among other countries would have been about 10% smaller. Purely analyzing China
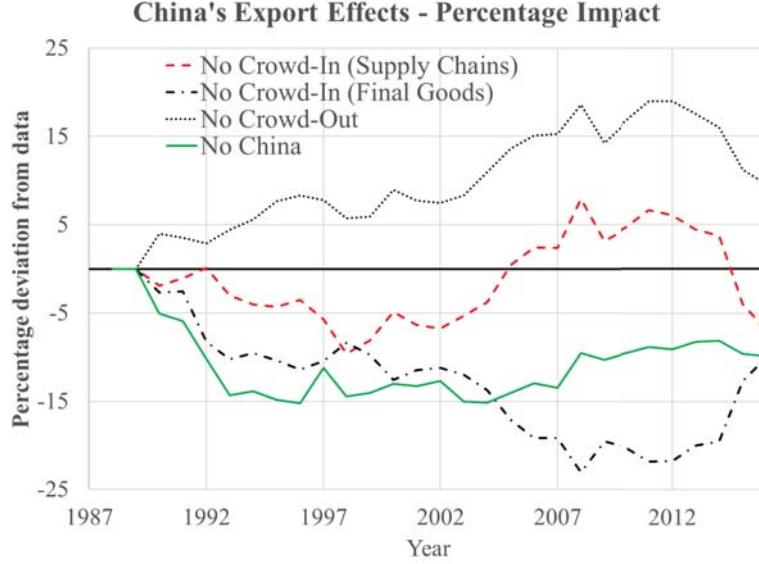
Figure 8: Counterfactual Percentage Impact

as an exporter only, its entry into global trade appears to have increased trade flows among other countries. This research does not attempt to make normative assertions on global welfare, as our analysis does not take into account domestic production and consumption. China's supply chain effect in crowding-in final goods appears to shift from negative to positive in 2005. A possible explanation is that China may have focused its production on supply chain inputs pre-2005 and shifted its production to mainly final goods post-2005. The directionality of both China's crowding-out and crowding-in of final goods effects are as expected. Absent China's crowding-out effect, world exports are projected significantly higher. Without China's crowding-in of final goods, world exports would be substantially less. Overall, China's supply chain effect is small compared to crowding-out. However, as this paper only considers China's exports, China's role as an importer is omitted in our research.

7   China's Import Effects: Future Work

At this point we investigated China's export effects. Future work should incorporate China's role as an importer. Including China's import effects in our model would add the following two summations of $\zeta_{ks,k's'}$ and $\rho_{ks,k's'}$ in addition to equation (5):

$$\sum_{k's'} \zeta_{ks,k's'} F_{China,i,k',s',t-1} + \sum_{k's'} \rho_{ks,k's'} F_{China,j,k',s',t-1}. \tag{14}$$

$\zeta_{ks,k's'}$ and $\rho_{ks,k's'}$ are the effects of China's imports of commodity and end-use $k's'$ from importer i and exporter j on country j's exports to i of ks. The parameters used to determine

China's crowding-in and crowding-out effects would be updated to reflect China's importer role.

7.1 Importer Effects: Crowding-In

In considering China's importer effects, we consider China's imports from the importer, i. Chinese imports act as a stimulus for an importing country to specialize in its exports. In other words, Chinese imports are a new market to which the importer may export. Consider again an example of trade flows from the US (exporter) to Japan (importer). If China imports from Japan, this induces Japan to specialize in production and boosts Japan's imports from other countries, like the US. (Figure 9).
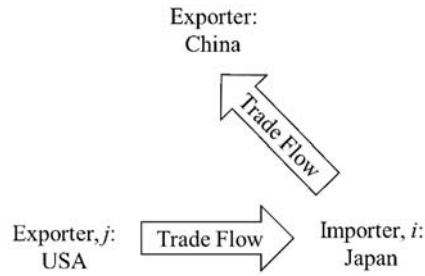

Figure 9: Crowding-In Importer Effects

Within the empirical model, equation (5) that includes (14), China's import effects via its imports from the importer are captured by the following summation of parameters:

$$\sum_{k's'} \zeta_{ks,k's'} F_{China,i,k',s',t-1} \tag{15}$$

when $k \neq k'$, i.e. when China's sector of imports do not match country j's sector of exports. This would be represented as the off-diagonals of matrix (6) for $\zeta_{ks,k's'}$.

7.2 Importer Effects: Crowding-Out

If China were to import from the exporting country j the commodity end-use combinations that country i originally imported from j, then China would be a crowding-out influence between i and j. In other words, If China diverts exports from the US that were previously exported to Japan, Japan would be crowded-out by China's role as an importer and will subsequently experience a decrease in imports (Figure 10).

The crowding-out effects presented by China's imports from the importing country are captured by:

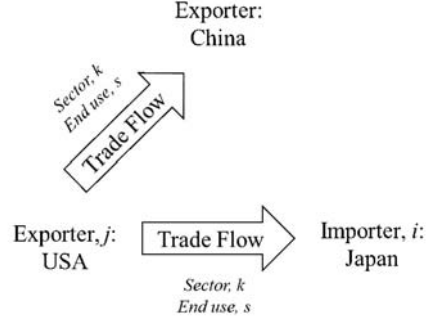$$\sum_{k's'} \rho_{ks,k's'} F_{China,j,k',s',t-1} \tag{16}$$

Figure 10: Crowding-Out Importer Effects

when sector, $k \neq k'$ and end-usage, $s \neq s'$. This would be represented as the diagonal of matrix (6) for $\rho_{ks,k's'}$.

Our research focuses on investigating crowding-in of final goods, crowding-in of supply chains, and crowding-out. There is some overlap in our estimated counterfactual effects. Future work can consider completely decomposing these three different channels of China's combined importer-exporter effect. By isolating China's three channels of influence, future research can partition China's influence without overlap.

7.3 Regression Method

Instead of using OLS regression, we would like to utilize a Poisson Quasi Maxiumum Likelihood estimator (PQML). The benefits to PQML are well recorded in trade literature as the best practice method of predicting trade flows (Silva and Tenreyro, 2006). As stated in section 6, PQML addresses the "adding up" problem of the standard gravity model by holding total predicted trade and total observed trade equal. Additionally, PQML better accounts for observations of zero trade. One of the challenges with the data is managing observations of zero-trade, instances where two countries do not trade a particular good in a given year. Since UNCOMTRADE records virtually no zero-trade observations between two countries, these zeros must be manually added to the dataset. However, there should be a distinction between "meaningful" and "non-meaningful" zeros. On the one hand, if the commodity has never been traded throughout any of the years (e.g. tropical fruit between Sweden and Finland), then it is not necessarily useful to add that observation of zero trade (Bacchetta, 2012). Within our dataset, if two countries had traded a commodity in at least one of the years, then an observation of zero trade of that commodity during the remaining years should be added. These zeros were not utilized in the OLS regression, but would be useful for future PQML analysis. The downside to using PQML on a model including exporter and importer impacts is the high computational cost. Running PQML estimation on 18 million observations with over 6,000 explanatory variables would take on the order of weeks to run.

Our dataset is inherently designed to support such future work. Other researchers

seeking to analyze trade benefits can benefit from a comprehensive dataset with 18 million observations that includes virtually every importer and exporter and differentiates between commodity industry and end-use. In truth, a country other than China can serve as the research focus.

References

Anderson, James E. and Eric Van Wincoop. (2003) 'Gravity And Gravitas: A Solution To The Border Puzzle', American Economic Review, v93(1,Mar), 170-192.

Athukorala, P.-C. (2009) 'The Rise of China and East Asian Export Performance: Is the Crowding-out Fear Warranted?' The World Economy 32, 234– 66.

Autor, D. H., Dorn, D. and Hanson, G. H. (2013) 'The China Syndrome: Local Labor Market Effects of Import Competition in the United States', American Economic Review 103, 2121– 68.

Bacchetta, Marc. (2012) 'A Practical Guide to Trade Policy Analysis', World Trade Organization.

Baldwin, Richard. (2009) 'The Great Trade Collapse: What caused it and what does it mean?', VOX, CEPR's Policy Portal.

Balsvik, R., Jensen, S. and Salvanes, K. G. (2015) 'Made in China, Sold in Norway: Local Labor Market Effects of an Import Shock', Journal of Public Economics 127, 137– 44.

Bernard, A. B., Jensen, J. B. and Schott, P. K. (2006) 'Survival of the Best Fit: Exposure to Low-Wage Countries and the (Uneven) Growth of U.S. Manufacturing Plants', Journal of International Economics 68, 219– 37.

Bloom, N., Draca, M. and Van Reenen, J. (2016) 'Trade Induced Technical Change? The Impact of Chinese Imports on Innovation, IT and Productivity', Review of Economic Studies 83, 81– 117.

Bloom, N., Romer, P. M., Terry, S. J. and Van Reenen, J. (2014) 'Trapped Factors and China's Impact on Global Growth', NBER Working Paper No. 19951.

Di Giovanni, Levchenko, and Zhang. (2014) 'The Global Welfare Impact of China: Trade Integration and Technological Change', American Economic Journal: Macroeconomics 2014, 6(3): 153–183.

Dimaranan, B., Ianchovichina, E. and Martin, W. (2007) 'Competing with Giants: Who Wins, Who Loses?' in L. A. Winters and S. Yusuf (eds), Dancing with Giants: China, India, and the Global Economy. Washington DC: The World Bank.

Ebenstein, A., McMillan, M., Zhao, Y. and Zhang, C. (2011) 'Understanding the Role of China in the 'Decline'of US Manufacturing', Manuscript, Hebrew University of Jerusalem.

Eichengreen, B., Rhee, Y. and Tong, H. (2007) 'China and the Exports of Other Asian Countries', Review of World Economics 143, 201– 26.

Fernald, J. G., Loungani, P., Ahearne, A. G. and Schindler, J. W. (2003) 'China and Emerging Asia: Comrades or Competitors?' Seoul Journal of Economics 16, 183– 214.

Freund, C. and Ozden, C. (2009) 'The Effect of China's Exports on Latin American Trade with the World', D. Lederman, M. Olarreaga and G. Perry (eds), China's and India's Challenge to Latin America: Opportunity or Threat?' Washington, DC: The World Bank.

Gaulier, G., Lemoine, F. and Ünal-Kesenci, D. (2007) 'China's Emergence and the Reorganisation of Trade Flows in Asia', China Economic Review 18, 209– 43.

Ghosh, M. and Rao, S. (2010) 'Chinese Accession to the WTO: Economic Implications for China, Other Asian and North American Economies', Journal of Policy Modeling 32, 389– 98.

Giovannetti, G. and Sanfilippo, M. (2009) 'Do Chinese Exports Crowd-out African Goods & Quest: An Econometric Analysis by Country and Sector', European Journal of Development Research 21, 506– 30.

Glenn and Sweeney. (2016) 'China Seizes Biggest Share of Global Exports in Almost 50 Years', Reuters.

Greenaway, D., Mahabir, A. and Milner, C. (2008) 'Has China Displaced Other Asian Countries' Exports?', China Economic Review 19, 152– 69.

Hanson and Robertson. (2008) 'China and the Manufacturing Exports of Other Developing Countries', NBER Working Paper No. 14497.

Hanson, G. H. and Robertson, R. (2009) 'China and the Recent Evolution of Latin America S Manufacturing Exports', D. Lederman, M. Olarreaga and G. Perry (eds), China's and India's Challenge to Latin America: Opportunity or Threat? Washington, DC: The World Bank.

Head, Keith. (2003) 'Gravity for Beginners', Faculty of Commerce, University of British Columbia.

IMF (2004) 'Chinese's Emergence and Its Impact on the Global Economy', World Economic Outlook, 82– 102.

Jenkins, R. (2008) 'China's Global Growth and Latin American Exports', UNU-WIDER Research Paper No. 2008.104.

Jenkins, R. and Barbosa, A. F. (2012) 'Fear for Manufacturing? China and the Future of Industry in Brazil and Latin America', The China Quarterly 209, 59– 81.

Jenkins, R. and Edwards, L. (2015) 'Is China 'Crowding Out' South African Exports of Manufactures?' European Journal of Development Research 1, 18.

Lall, S., Weiss, J. and Oikawa, H. (2005) 'China's Competitive Threat to Latin America: An Analysis for 1990–2002', Oxford Development Studies 33, 163– 94.

Mayer and Wood. (2009) 'Has China De-industrialized Other Developing Countries?', VOX, CEPR's Policy Portal.

Mayer, T. and Zignago, S. (2011) 'Notes on CEPII's distances measures: The GeoDist database', CEPII Working Paper 2011- 25, December 2011, CEPII.

Qiu, L. D., and Zhan, C. (2016) China's Global Influence: A Survey through the Lens of International Trade. Pacific Economic Review, 21: 45– 71.

Qureshi, M. S. and Wan, G. (2008) 'Trade Expansion of China and India: Threat or Opportunity?' The World Economy 31, 1327– 50.

Redding, Stephen Venables, Anthony J. (2004) 'Economic geography and international inequality', Journal of International Economics, Elsevier, vol. 62(1), pages 53-82, January.

Shepherd, B. (2016) 'The Gravity Model of International Trade: A User Guide', United Nation Publication.

Scissors, D., Espinoza, C. and Miller, T. (2012) 'Trade Freedom: How Imports Support US Jobs', Heritage Foundation Backgrounder No.2725.

Silva and Tenreyro. (2006) 'The Log of Gravity', The Review of Economics and Statistics, vol 88, issue 4, 641-658.

Utar, H. (2014) 'When the Floodgates Open: "Northern" Firms' Response to Removal of Trade Quotas on Chinese Goods', American Economic Journal: Applied Economics 6, 226– 50.

Appendix A   Appendix

A.1   Importing and Exporting Countries

- Aruba
- Afghanistan
- Angola
- Anguilla
- Albania
- Andorra
- Netherlands Antilles
- United Arab Emirates
- Argentina
- Armenia
- American Samoa
- Antarctica
- French Southern Territories
- Antigua and Barbuda
- Australia
- Austria
- Azerbaijan
- Burundi
- Belgium
- Benin
- Bonaire, Sint Eustatius and Saba
- Burkina Faso
- Bangladesh
- Bulgaria
- Bahrain
- Bahamas
- Bosnia and Herzegovina
- Saint Barthélemy
- Belarus
- Belize
- Bermuda
- Bolivia (Plurinational State of)
- Brazil
- Barbados
- Brunei Darussalam
- Bhutan
- Bouvet Island
- Botswana
- Central African Republic
- Canada
- Cocos (Keeling) Islands
- Switzerland
- Chile
- China
- Côte d'Ivoire
- Cameroon
- Democratic Republic of the Congo
- Congo
- Cook Islands
- Colombia
- Comoros
- Cabo Verde
- Costa Rica
- Czechoslovakia
- Cuba
- Curaçao
- Christmas Island
- Cayman Islands
- Cyprus
- Czechia
- German Democratic Republic
- Germany
- Djibouti
- Dominica
- Denmark
- Dominican Republic
- Algeria
- Ecuador
- Egypt
- Eritrea
- Western Sahara
- Spain
- Estonia
- Ethiopia
- Finland
- Fiji
- Falkland Islands (Malvinas)
- France
- Faroe Islands
- Micronesia (Federated States of)
- Gabon
- United Kingdom of Great Britain and Northern Ireland
- Georgia
- Ghana
- Gibraltar
- Guinea
- Guadeloupe
- Gambia
- Guinea-Bissau
- Equatorial Guinea
- Greece
- Grenada
- Greenland
- Guatemala
- French Guiana
- Guam
- Guyana
- China, Hong Kong Special Administrative Region
- Heard Island and McDonald Islands
- Honduras
- Croatia
- Haiti

- Hungary
- Indonesia
- India
- British Indian Ocean Territory
- Ireland
- Iran (Islamic Republic of)
- Iraq
- Iceland
- Israel
- Italy
- Jamaica
- Jordan
- Japan
- Kazakhstan
- Kenya
- Kyrgyzstan
- Cambodia
- Kiribati
- Saint Kitts and Nevis
- Republic of Korea
- Kuwait
- Lao People's Democratic Republic
- Lebanon
- Liberia
- Libya
- Saint Lucia
- Sri Lanka
- Lesotho
- Lithuania
- Luxembourg
- Latvia
- China, Macao Special Administrative Region
- Morocco
- Republic of Moldova
- Madagascar
- Maldives
- Mexico
- Marshall Islands

- The former Yugoslav Republic of Macedonia
- Mali
- Malta
- Myanmar
- Montenegro
- Mongolia
- Northern Mariana Islands
- Mozambique
- Mauritania
- Montserrat
- Martinique
- Mauritius
- Malawi
- Malaysia
- Mayotte
- Namibia
- New Caledonia
- Niger
- Norfolk Island
- Nigeria
- Nicaragua
- Niue
- Netherlands
- Norway
- Nepal
- Nauru
- New Zealand
- Oman
- Pakistan
- Panama
- Pacific Islands (Trust Territory)
- Pitcairn
- Peru
- Philippines
- Palau
- Papua New Guinea
- Poland
- Democratic People's Republic of Korea

- Portugal
- Paraguay
- State of Palestine
- French Polynesia
- Qatar
- Réunion
- Romania
- Russian Federation
- Rwanda
- Saudi Arabia
- Serbia and Montenegro
- Sudan
- Senegal
- Singapore
- South Georgia and the South Sandwich Islands
- Saint Helena
- Solomon Islands
- Sierra Leone
- El Salvador
- San Marino
- Somalia
- Saint Pierre and Miquelon
- Serbia
- South Sudan
- Sao Tome and Principe
- USSR
- Suriname
- Slovakia
- Slovenia
- Sweden
- Eswatini
- Sint Maarten (Dutch part)
- Seychelles
- Syrian Arab Republic
- Turks and Caicos Islands
- Chad
- Togo
- Thailand
- Tajikistan

- Tokelau
- Turkmenistan
- Timor-Leste
- Tonga
- Trinidad and Tobago
- Tunisia
- Turkey
- Tuvalu
- United Republic of Tanzania
- Uganda
- Ukraine
- United States Minor Outlying Islands
- Uruguay
- United States of America
- Uzbekistan
- Holy See
- Saint Vincent and the Grenadines
- Venezuela (Bolivarian Republic of)
- British Virgin Islands
- Viet Nam
- Vanuatu
- Wallis and Futuna Islands
- Samoa
- Yemen
- Yemen, Democratic
- Yugoslavia
- South Africa
- Zambia
- Zimbabwe

A.2 Geographic Regions

- Antarctica
- Australia and New Zealand
- Central Asia
- Eastern Asia
- Eastern Europe
- Latin America and the
- Caribbean
- Melanesia
- Micronesia
- Northern Africa
- Northern America
- Northern Europe
- Polynesia
- South-eastern Asia
- Southern Asia
- Southern Europe
- Sub-Saharan Africa
- Western Asia
- Western Europe

A.3 Continent Regions

- Africa
- Americas
- Asia
- Europe
- Oceania
- Antarctica

A.4 Harmonized System Sections

- 01 - Live Animals; Animal Products
- 02 - Vegetable Products
- 03 - Animal Or Vegetable Fats And Oils And Their Cleavage Products; Prepared Edible Fats; Animal Or Vegetable Waxes
- 04 - Prepared Foodstuffs; Beverages, Spirits, And Vinegar; Tobacco And Manufactured Tobacco Substitutes
- 05 - Mineral Products
- 06 - Products Of The Chemical Or Allied Industries
- 07 - Plastics And Articles Thereof Rubber And Articles Thereof
- 08 - Raw Hides And Skins, Leather, Furskins And Articles Thereof; Saddlery And Harness; Travel Goods, Handbags And Similar Containers; Articles Of Animal Gut (Other Than Silkworm Gut)
- 09 - Wood And Articles

Of Wood; Wood Charcoal; Cork And Articles Of Cork; Manufacturers Of Straw, Of Esparto Or Of Other Plaiting Materials; Basketware And Wickerwork

- 10 - Pulp Of Wood Or Of Other Fibrous Cellulosic Material; Waste And Scrap Of Paper Or Paperboard; Paper And Paperboard And Articles Thereof
- 11 - Textile And Textile Articles
- 12 - Footwear, Headgear, Umbrellas, Sun Umbrellas, Walking Sticks, Seatsticks, Whips, Riding-Crops And Parts Thereof; Prepared Feathers And Articles Made Therewith; Artificial Flowers; Articles Of Human Hair
- 13 - Articles Of Stone, Plaster, Cement, Asbestos, Mica Or Similar Materials; Ceramic Products; Glass And Glassware
- 14 - Natural Or Cul-

tured Pearls, Precious Or Semi-Precious Stones, Precious Metals, Metals Clad With Precious Metal And Articles Thereof; Imitation Jewelry; Coin

- 15 - Base Metals And Articles Of Base Metal
- 16 - Machinery And Mechanical Appliances; Electrical Equipment; Parts Thereof; Sound Recorders And Reproducers, Television Image And Sound Recorders And Reproducers, And Parts And Accessories Of Such Articles
- 17 - Vehicles, Aircraft, Vessels And Associated Transport Equipment
- 18 - Optical, Photographic, Cinematographic, Measuring, Checking, Precision, Medical Or Surgical Instruments And Apparatus; Clocks And Watches; Musical Instruments; Parts And Accessories Thereof
- 19 - Arms And Ammu-

nition; Parts And Accessories Thereof

- 20 - Miscellaneous Manufactured Articles
- 21 - Works Of Art, Collectors' Pieces And Antiques
- 22 - Special Classification Provisions; Temporary Legislation; Temporary Modifications Proclaimed Pursuant To Trade Agreements Legislation; Additional Import Restrictions Proclaimed Pursuant To Section 22 Of The Agricultural Adjustment Act, As Amended
- 23 - Special Classification Provisions; Temporary Legislation; Temporary Modifications Proclaimed Pursuant To Trade Agreements Legislation; Additional Import Restrictions Proclaimed Pursuant To Section 22 Of The Agricultural Adjustment Act, As Amended